TwinSol Group Activities

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1 Radioactive Beam Studies
   - $^8$Li Coulomb Excitation
   - $^8$Li and $^8$B Production

2 Deuterated Scintillator

3 $0\nu2\beta$ Matrix Elements
Basic Setup

Figure: TwinSol beamline.
Basic Setup

Figure: Radioactive ion production target.
Figure: $^8\text{Li}$ production.
Physics interest

- Probe nuclear structure of n-rich nuclei
- Transfer can occur into $^8\text{Li}^*$
- Want to probe $^8\text{Li}^*$ at secondary Au target
- Use energy and timing separation
- Experiment ran in April
Figure: Some important nuclei for $\beta$ beams.
Novel detectors

Deuterated Benzene ($C_6D_6$)

- Kinematics and isospin different from hydrogen
- Possibility of pulse shape discrimination for n-γ
- Tests seek to reproduce known cross sections
- Detectors small and rather flexible (compare to neutron wall)
Cross Section

Figure: d(d,n) cross section in the lab.
Physics Motivation

- $0\nu2\beta$ important probe of Electro-Weak Symmetry Breaking
- Process uncover if neutrino mass is Dirac or Majorana
- Process yeilds a kind of direct measure of mass rather than mass difference
- **IF** one knows the nuclear matrix elements
- We can probe ME’s which are intimately related through proton transfer
Time-of-Flight Measurements

Figure: $^{26}\text{Mg}(^{3}\text{He},n)$ timing data.
Background Problems

Background Suppression

- Uncorrelated timing background from cosmics and low energy $\gamma$’s
- This background should be removed if possible to increase statistical significance
- $\mu$-veto detectors are being constructed with surplus plastic scintillator

Timing

- Buncher timing necessary to probe ground state transitions only
- Timing resolution approximately 2 ns dominated by bunching
Cosmic Ray Veto

Figure: Detecting time-correlated cosmics. This gives low rate due to small BaF$_2$ crystal.
Spare neutrons?

Figure: Used bunched neutrons in west target room.
Figure: Subtracted timing spectra with energy threshold of ch. 200.
Timing Spectra (2)

Figure: The rejected events.
Figure: Rejection efficiency as a function of energy threshold.
Figure: Rejection efficiency as a function of energy threshold for top veto.
Summary

**8^Li Coulex studies**
- Data taken and analyzing for reduced multipole amplitudes.

**Liquid Scintillators for Neutrons**
- Data taken and using to extract known cross sections with definite neutron energy groups.
- PhD thesis completed on subject (M. Ojaruega University of Michigan)

**Cosmic Veto**
- Rough rejection ratios obtained with standard setup
- Exploring wave-shifting fiber readout